A bankable method for the field testing of a CPV plant

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ABSTRACT

The bankability of CPV projects is an important issue to pave the way toward a swift and sustained growth in this technology. The bankability of a PV plant is generally addressed through the modeling of its energy yield under a baseline loss scenario, followed by an on-site measurement campaign aimed at verifying its energetic behavior. The main difference between PV and CPV resides in the proper CPV modules, in particular in the inclusion of optical elements and III-V multijunction cells that are much more sensitive to spectral variations than xSi cells, while the rest of the system behaves in a way that possesses many common points with xSi technology. The modeling of the DC power output of a CPV system thus requires several important second order parameters to be considered, mainly related to optics, spectral direct solar radiation, wind speed, tracker accuracy and heat dissipation of cells.

During the last 5 years, the Universidad Politécnica de Madrid (UPM) and Universidad Politécnica de Jaén (UJAEN) have offered both indoor and outdoor control quality services to the PV and CPV industry, and have carried out on-site quality controls campaigns for 55 PV plants totaling more than 250 MW, in close relation with Engineering, Procurement and Construction Contractors (EPCC). The results have been published in other works[1]. Both universities have also been taking extensive meteorological measurements at their facilities in Madrid[2] and Jaén[3].

This paper proposes a methodology for assessing the performance of a CPV project, articulated around four main successive steps: Solar Resource Assessment, Yield Assessment, Certificate of Provisional Acceptance, and Certificate of Final Acceptance. This methodology allows estimating the long-term energy production of a CPV project with an uncertainty that is around $\sigma = 5\%$.

The long-term trend of DNI is determined from a satellite or ground-based dataset, with ideally more than 10 years of data. The spectral distribution of DNI can be simulated using a high resolution clear-sky model, as SMARTS[4]. Previously to the construction of the CPV project, if the situation allows for it, a ground-measurement campaign of at least one-year length is carried on. The possible bias of the DNI dataset is then corrected by comparison with the shorter-term values taken during the measurement campaign.

The Yield Assessment is carried out before the construction of the project using a physical model which is used to simulate the energetic yield of a reference CPV system, whose technical characteristics are extracted directly from the technical information supplied by the EPCC, i.e. its performance is assumed to be optimal, and all its components are assumed to correspond exactly to the technical datasheets of the manufacturers. After estimating the energy produced by the reference system, all of the parts involved in the project (EPCC, investors and independent experts) agree on a baseline loss scenario establishing the maximum difference authorized between the performance of the reference CPV system and the real system to be constructed. Figure 1 shows a comparison between target power and measured power for a CPV module installed at UJAEN.

The Certificate of Provisional Acceptance is delivered on the basis of on-site measurements that are generally taken just after the commissioning of the CPV project and whose duration is typically of one or two weeks under clear-sky conditions.

Finally, the Certificate of Final Acceptance is awarded on the basis of a continuous monitoring campaign that takes place at the CPV plant 1 or 2 years after its commissioning. The CFA verifies the quality of the operation and maintenance, and looks for hidden defects, or second-order causes of energy losses that were not possible to assess during the CPA.

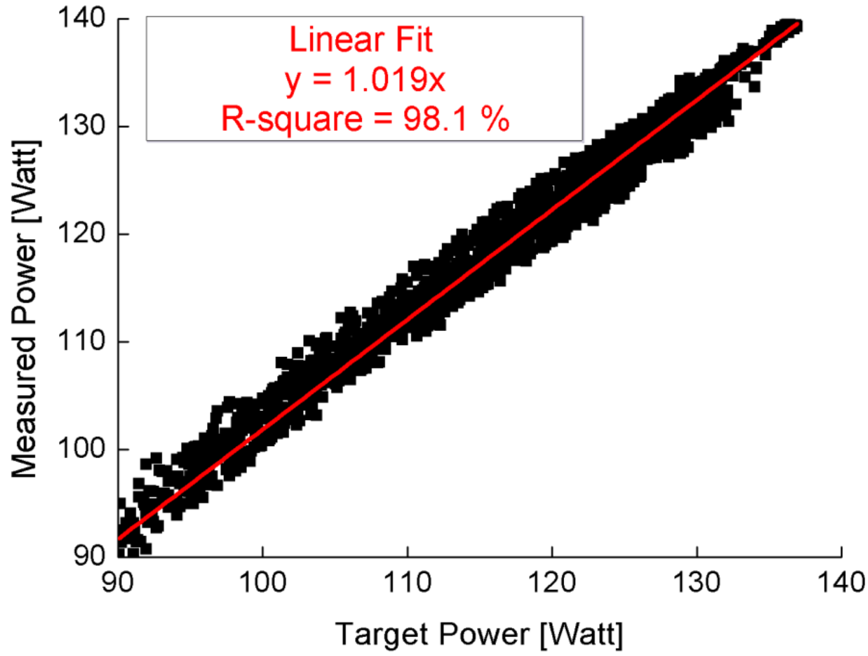

Figure 1: Comparison between target power and measured power for a CPV module installed at UJAEN, under clear-sky conditions (DNI > 600 W/m^2) and for the whole month of July, 2011.

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